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ABSTRACT

The U.S. Environmental Protection Agency (EPA) and the U.S. Centers for Disease Control (CDC) are concerned about the increased risk of developing lung cancer faced by persons exposed to above-average levels of radon in their homes. The purpose of this pamphlet is to help readers to understand the radon problem and decide if they need to take action to reduce radon levels in their homes. Topics discussed include: (1) what radon is; (2) why radon is a problem; (3) how radon gets into a home; (4) how to detect radon; (5) evaluating radon risk; (6) how to take action; and (7) how to reduce radon risk. (CW)

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United States
Environmental Protection
Agency

Office of
Air and Radiation

U.S. Department
Of Health and
Human Services

Centers for
Disease Control

August 1986

OPA-86-004

A Citizen's Guide To Radon

What It Is And What To Do About It

U.S. DEPARTMENT OF EDUCATION
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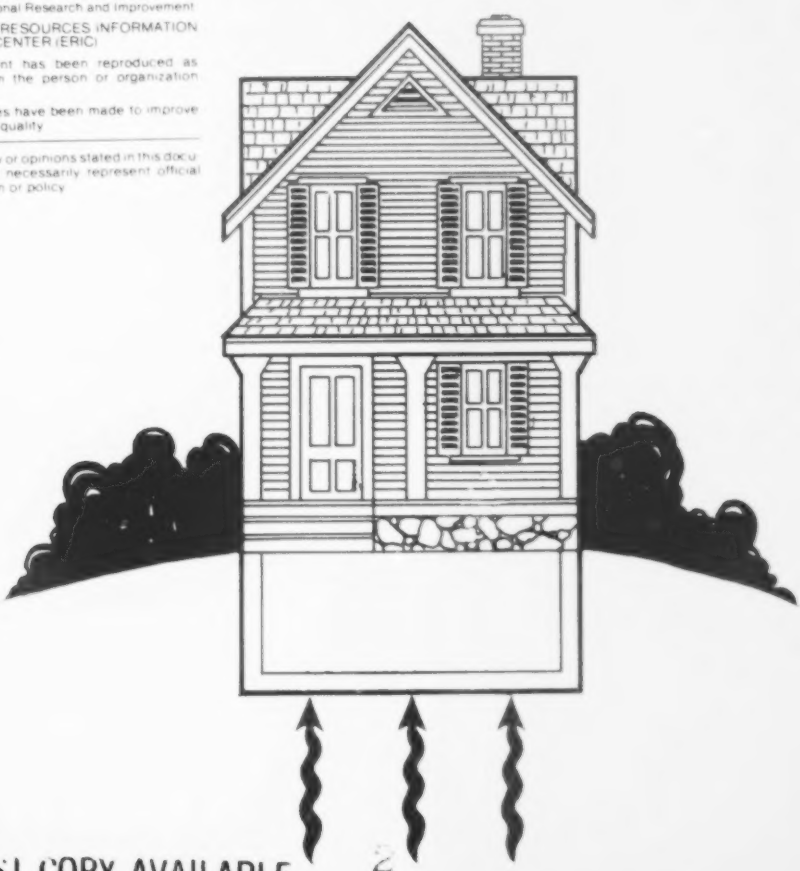

SE 050 319

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The U.S. Environmental Protection Agency and the U.S Centers for Disease Control are concerned about the increased risk of developing lung cancer faced by persons exposed to above-average levels of radon in their homes. This pamphlet is a joint effort by EPA and CDC. Its purpose is to help readers to understand the radon problem and decide if they need to take action to reduce radon levels in their homes.

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What is radon?

Radon is a radioactive gas which occurs in nature. You cannot see it, smell it, or taste it.

Where does radon come from?

Radon comes from the natural breakdown (radioactive decay) of uranium. Radon can be found in high concentrations in soils and rocks containing uranium, granite, shale, phosphate, and pitchblende. Radon may also be found in soils contaminated with certain types of industrial wastes, such as the byproducts from uranium or phosphate mining.

In outdoor air, radon is diluted to such low concentrations that it is usually nothing to worry about. However, once inside an enclosed space (such as a home) radon can accumulate. Indoor levels depend both on a building's construction and the concentration of radon in the underlying soil.

How does radon affect me?

The only known health effect associated with exposure to elevated levels of radon is an increased risk of developing lung cancer. Not everyone exposed to elevated levels of radon will develop lung cancer, and the time between exposure and the onset of the disease may be many years.

Scientists estimate that from about 5,000 to about 20,000 lung cancer deaths a year in the United States may be attributed to radon. (The American Cancer Society expects that about 130,000 people will die of lung cancer in 1986. The Surgeon General attributes around 85 percent of all lung cancer deaths to smoking.)

Your risk of developing lung cancer from exposure to radon depends upon the concentration of radon and the length of time you are exposed. Exposure to a slightly elevated radon level for a long time may present a greater risk of developing lung cancer than exposure to a significantly elevated level for a short time. In general, your risk increases as the level of radon and the length of exposure increase.

How certain are scientists of the risks?

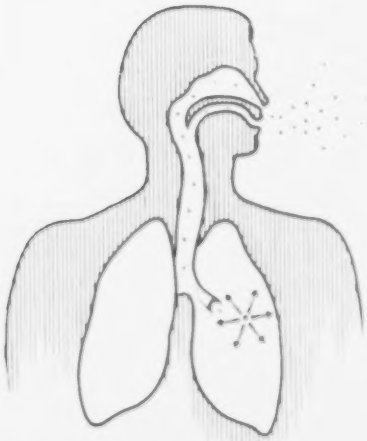
With exposure to radon, as with other pollutants, there is some uncertainty about the amount of health risk. Radon risk estimates are based on scientific studies of miners exposed to varying levels of radon in their work underground. Consequently, scientists are considerably more certain of the risk estimates for radon than they are of those risk estimates which rely solely on studies of animals.

To account for the uncertainty in the risk estimates for radon, scientists generally express the risks associated with exposure to a particular level as a *range* of numbers. (The risk estimates given in this booklet are based on the advice of EPA's Science Advisory Board, an independent group of scientists established to advise EPA on various scientific matters.)

Despite some uncertainty in the risk estimates for radon, it is widely believed that **the greater your exposure to radon, the greater your risk of developing lung cancer.**

How does radon cause lung cancer?

Radon, itself, naturally breaks down and forms radioactive decay products. As you breathe, the radon decay products can become trapped in your lungs. As these decay products break down further, they release small bursts of energy which can damage lung tissue and lead to lung cancer.



When did radon become a problem?

Radon has always been present in the air. Concern about elevated indoor concentrations first arose in the late 1960's when homes were found in the West that had been built with materials contaminated by waste from uranium mines. Since then, cases of high indoor radon levels resulting from industrial activities have been found in many parts of the country. We have only recently become aware, however, that houses in various parts of the U.S. may have high indoor radon levels caused by *natural* deposits of uranium in the soil on which they are built.

Does every home have a problem?

No, most houses in this country are not likely to have a radon problem; but relatively few houses do have highly elevated levels. The dilemma is that, right now, no one knows which houses have a problem and which do not. You may wish to call your state radiation protection office to find out if any high levels have been discovered in your area.

Many states, as well as the federal government, are sponsoring work to identify areas of the country which are likely to have indoor radon problems. However, early results from this work are inconclusive. If you are concerned that you may have an indoor radon problem, you should consider having your home tested.

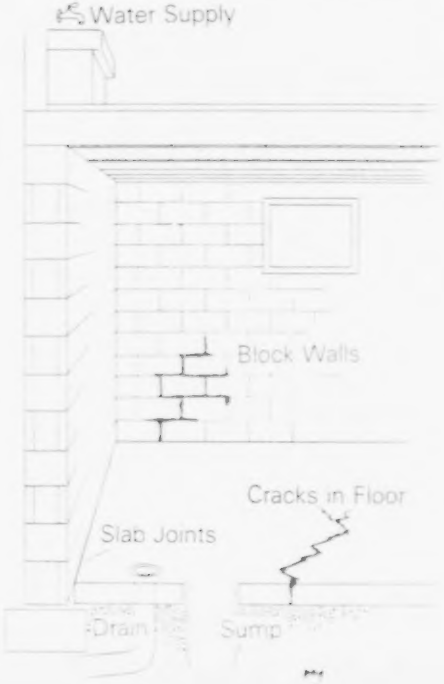
How does radon get into a home?

Radon is a gas which can move through small spaces in the soil and rock on which a house is built. Radon can seep into a home through dirt floors, cracks in concrete floors and walls, floor drains, sumps, joints, and tiny cracks or pores in hollow-block walls.

Radon also can enter water within private wells and be released into a home when the water is used. Usually, radon is not a problem with large community water supplies, where it would likely be released into the outside air before the water reaches a home. (For more information concerning radon in water, contact your state's radiation protection office.)

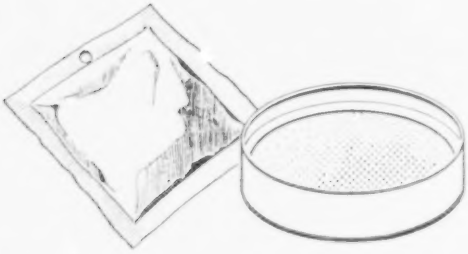
In some unusual situations, radon may be released from the materials used in the construction of a home. For example, this may be a problem if a house has a large stone fireplace or has a solar heating system in which heat is stored in large beds of stone. In general, however, building materials are not a major source of indoor radon.

Common Radon Entry Points



How is radon detected?

Since you cannot see or smell radon, special equipment is needed to detect it. The two most popular, commercially-available radon detectors are the charcoal canister and the alpha track detector. Both of these devices are exposed to the air in your home for a specified period of time and sent to a laboratory for analysis.



Charcoal Canisters

Test Period: 3 to 7 days
Approximate Cost: $10 to $25 for one canister

Alpha Track Detectors

Minimum Test Period: 2 to 4 weeks
Approximate Cost: $20 to $50 for one detector; discounts for multiple detectors

There are other techniques—requiring operation by trained personnel—which can be used to measure radon levels, but such techniques may be more expensive than the devices shown above.

Your measurement result will be reported to you in one of two ways. Results from devices which measure radon decay products are reported as "Working Levels" (WL). Results from devices which measure concentrations of radon gas are reported as "picocuries per liter" (pCi/l).

How can I get a radon detector?

Homeowners in some areas are being provided with detectors by their state or local government. In many areas, private firms offer radon testing. Your state radiation protection office may be able to provide you with information on the availability of detection devices or services.

The U.S. Environmental Protection Agency conducts a Radon Measurement Proficiency Program. This voluntary program allows laboratories and businesses to demonstrate their capabilities in measuring indoor radon. The names of firms participating in this program can be obtained from your state radiation protection office or from your EPA regional office.

How should radon detectors be used?

Obtaining a useful estimate of the radon level in your home may require that several detectors be used to make measurements in different areas. Following the steps below should provide the information needed as you decide whether or not further action is advisable. (In making radon measurements, you should be sure to follow the instructions of the manufacturer as to the proper exposure period for the particular device you are using.)

Step One: The screening measurement

The first step you should take is to have a short-term "screening" measurement made to give you an idea of the highest radon level in your home. Thus, you can find out quickly and inexpensively whether or not you have a potential radon problem.

The screening measurement should be made in the lowest livable area of your home (the basement, if you have one). All windows and doors should be closed for at least 12 hours prior to the start of the test, and kept closed as much as possible throughout the testing period. This is necessary to keep the radon level relatively constant throughout the testing period. Because of the need to keep the windows closed as much as possible, we recommend that you make short-term radon measurements during the cool months of the year.

Step Two: Determining the need for further measurements

In most cases, the screening measurement is not a reliable measure of the *average* radon level to which you and your family are exposed. Since radon levels can vary greatly from season to season as well as from room to room, the screening measurement only serves to indicate the *potential* for a radon problem. Depending upon the result of your screening measurement, you may need to have follow-up measurements made to give you a better idea of the average radon level in your home.

The following guidance may be useful to you in determining the urgency of your need for follow-up measurements.

If your screening measurement result is **greater than about 1.0 WL** or **greater than about 200 pCi/l**, you should perform follow-up measurements as soon as possible. Expose the detectors for no more than one week. Doors and windows should be closed as much as possible during testing. You should also consider taking actions (see page 13) to immediately reduce the radon levels in your home.

If your screening measurement result is **about 0.1 WL to about 1.0 WL** or **about 20 pCi/l to about 200 pCi/l**, perform follow-up measurements. Expose detectors for no more than three months. Doors and windows should be closed as much as possible during testing.

If your screening measurement result is **about 0.02 WL to about 0.1 WL** or **about 4 pCi/l to about 20 pCi/l**, perform follow-up measurements. Expose detectors for one year, or make measurements of no more than one week duration during each of the four seasons.

If your screening measurement result is **less than about 0.02 WL** or **less than about 4 pCi/l**, follow-up measurements are probably not required. If the screening measurement was made with the house closed up prior to and during the testing period, there is relatively little chance that the radon concentration in your home will be greater than 0.02 WL or 4 pCi/l as an annual average.

Step Three: The follow-up measurement

Follow-up measurements will provide you with a relatively good estimate of the average radon concentration to which you and your family are exposed. **We strongly recommend that you make follow-up measurements before you make any final decisions about whether to undertake major efforts to permanently correct the problem.**

Follow-up measurements should be made in at least two lived-in areas of your home. If your home has lived-in areas on more than one floor, you should make measurements in a room on each of the floors. An example is to take a measurement in the living room on the first floor and another in a second-floor bedroom. The results of the follow-up measurements should be averaged together.

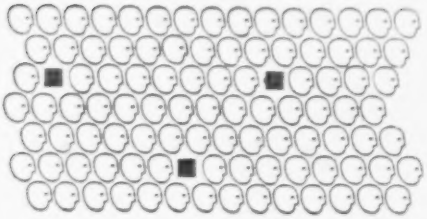
What do my test results mean?

The results of your follow-up measurements provide you with an idea of the average concentration throughout your home. The actual risk you face depends upon the amount of time you are exposed to this concentration.

The figures on the facing page illustrate the number of lung cancer deaths, out of a group of 100 people, that scientists would attribute to exposure to specific levels of indoor radon. The first three figures assume that these 100 individuals spent 75 percent of their time in the dwelling for 70 years. The numbers below each picture indicate what scientists consider to be a reasonable range of estimates of lung cancer deaths that could be attributed to the radon exposure. This is **in addition to** the number of lung cancer deaths attributed to other causes. (On average, about four people out of a hundred die of lung cancer from all causes combined.) The pictures represent the midpoint of the ranges.

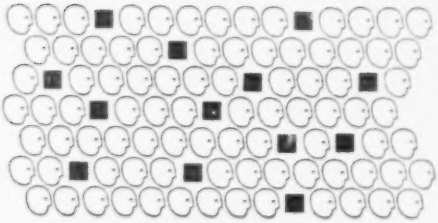
Lung Cancer Deaths Associated With Exposure To Various Radon Levels Over 70 Years

WL = 0.02
pCi/l = 4



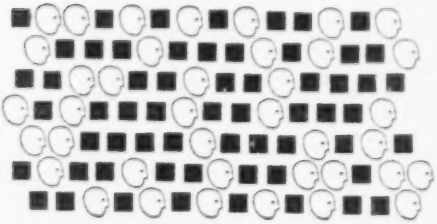
Between 1 and 5 out of 100

WL = 0.1
pCi/l = 20



Between 6 and 21 out of 100

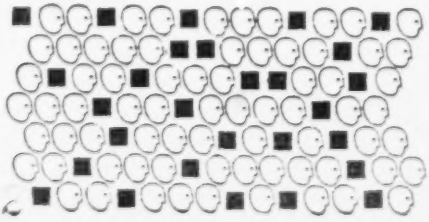
WL = 1.0
pCi/l = 200



Between 44 and 77 out of 100

If these same 100 individuals had lived only 10 years (instead of 70) in houses with radon levels of about 1.0 WL, the number of lung cancer deaths expected would be:

WL = 1.0
pCi/l = 200



Between 14 and 42 out of 100

Another way to think about the risk associated with radon exposure is to compare it with the risk from other activities. The chart below gives an idea of how exposure to various radon levels over a lifetime compares to the risk of developing lung cancer from smoking and from chest x-rays. The chart also compares these levels to the average indoor and outdoor radon concentrations.

As you look at the chart, be sure to use the proper radon-level column for your results (either WL or pCi/l).

Radon Risk Evaluation Chart

pCi/l	WL	Estimated number of lung cancer deaths due to radon exposure (out of 1000)	Comparable exposure levels	Comparable risk
200	1	440—770	1000 times average outdoor level	More than 60 times non-smoker risk
				4 pack-a-day smoker
100	0.5	270—630	100 times average indoor level	
				20,000 chest x-rays per year
40	0.2	120—380		
				2 pack-a-day smoker
20	0.1	60—210	100 times average outdoor level	
				1 pack-a-day smoker
10	0.05	30—120	10 times average indoor level	
				5 times non-smoker risk
4	0.02	13—50		
				200 chest x-rays per year
2	0.01	7—30	10 times average outdoor level	
				Non-smoker risk of dying from lung cancer
1	0.005	3—13	Average indoor level	
0.2	0.001	1—3	Average outdoor level	20 chest x-rays per year

How quickly should I take action?

In considering whether and how quickly to take action based on your test results, you may find the following guidelines useful. EPA believes that you should try to permanently reduce your radon levels as much as possible. Based on currently available information, EPA believes that levels in most homes can be reduced to about 0.02 WL (4 pCi/l).

If your results are about 1.0 WL or higher, *or* **about 200 pCi/l or higher:**
Exposures in this range are among the highest observed in homes. Residents should undertake action to reduce levels as far below 1.0 WL (200 pCi/l) as possible. We recommend that you take action within several weeks. If this is not possible, you should determine, in consultation with appropriate state or local health or radiation protection officials, if temporary relocation is appropriate until the levels can be reduced.

If your results are about 0.1 to about 1.0 WL, *or* **about 20 to about 200 pCi/l:**
Exposures in this range are considered greatly above average for residential structures. You should undertake action to reduce levels as far below 0.1 WL (20 pCi/l) as possible. We recommend that you take action within several months.

If your results are about 0.02 to about 0.1 WL, *or* **about 4 pCi/l to about 20 pCi/l:**
Exposures in this range are considered above average for residential structures. You should undertake action to lower levels to about 0.02 WL (4 pCi/l) or below. We recommend that you take action within a few years, sooner if levels are at the upper end of this range.

If your results are about 0.02 WL or lower, *or* **about 4 pCi/l or lower:**
Exposures in this range are considered average or slightly above average for residential structures. Although exposures in this range do present some risk of lung cancer, reductions of levels this low may be difficult, and sometimes impossible, to achieve.

Remember: There is increasing urgency for action at higher concentrations of radon. The higher the radon level in your home, the faster you should take action to reduce your exposure. If you find elevated radon concentrations in your home, you should take the relatively easy, short-term actions described on page 13.

Are there other factors I should consider?

Most of the risk information given in this pamphlet, as well as the recommendations for taking corrective action, are based on the general case. Your individual living patterns could influence your assessment of your risk and your decisions about the need for further action. Your answers to the following questions may help you evaluate your personal risk.

- Does anyone smoke in your home? Scientific evidence indicates that smoking may increase the risk of exposure to radon. In addition, smoking significantly increases your overall risk of lung cancer.

- Do you have children living at home? Although there are no studies of children exposed to radon to determine whether they are more sensitive than adults, some scientific studies of other types of radiation exposure indicate that children may be more sensitive. Consequently, children could be more at risk than adults from exposure to radon.

- How much time does any family member spend at home? The risk estimates given in this pamphlet assume that 75 percent of a person's time is spent at home. If you or your family spend more or less time at home, you should take this into consideration.

- Does anyone sleep in your basement? Since radon concentrations tend to be greater on the lower levels of a home, a person who sleeps in the basement is likely to face a greater risk than a person who sleeps in a second-floor bedroom.

- How long will you live in your home? The risk estimates in this booklet are based on the assumption that you will be exposed to the radon level found in your home for roughly 70 years. As you evaluate your potential risk, therefore, you might consider the total amount of time you expect to live in your home. But remember: other houses you have lived in—or will live in—may have the same or higher radon levels.

How can I reduce my risk from radon?

Your risk of lung cancer from exposure to radon depends upon the amount of radon entering your home and the length of time it remains in your living areas. Listed below are some actions you might take to immediately reduce your risk from radon. These actions can be done quickly and with minimum expense in most cases.

- Stop smoking and discourage smoking in your home. By doing so, you should reduce your family's overall chance of developing lung cancer, as well as reducing your family's risk from radon exposure.
- Spend less time in areas with higher concentrations of radon, such as the basement.
- Whenever practical, open all windows and turn on fans to increase the air flow into and through the house. This is especially important in the basement.
- If your home has a crawl space beneath, keep the crawl-space vents on all sides of the house fully open all year.

While the above actions will help reduce your risk from radon, they generally do not offer a long-term solution. You can find more information about permanent, cost-effective solutions to a radon problem in the EPA publication, *Radon Reduction Methods: A Homeowner's Guide*. A copy of this booklet may be obtained from your state radiation protection office or from your EPA regional office.

Before undertaking major modifications to your home, we recommend that you consult with your state radiation protection office to obtain whatever specific advice or assistance they may be able to provide for your particular situation.

Sources of Information

If you would like further information or explanation on any of the points mentioned in this booklet, you should contact your state radiation protection office.

If you have difficulty locating this office, you may call your EPA regional office listed below. They will be happy to provide you with the name, address, and telephone number for your appropriate state contact.

State—EPA Region

Alabama—4
Alaska—10
Arizona—9
Arkansas—6
California—9
Colorado—8
Connecticut—1
Delaware—3
District of Columbia—3
Florida—4
Georgia—4
Hawaii—9
Idaho—10
Illinois—5
Indiana—5
Iowa—7
Kansas—7
Kentucky—4
Louisiana—6
Maine—1
Maryland—3
Massachusetts—1
Michigan—5
Minnesota—5
Mississippi—4
Missouri—7
Montana—8
Nebraska—7
Nevada—9
New Hampshire—1
New Jersey—2
New Mexico—6
New York—2
North Carolina—4
North Dakota—8
Ohio—5
Oklahoma—6
Oregon—10
Pennsylvania—3
Rhode Island—1
South Carolina—4
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